

## TITLE OF THE INVENTION

Image Recording Apparatus

## BACKGROUND OF THE INVENTION

### 5 Field of the invention

The present invention relates to an image recording apparatus applied to a surveillance camera apparatus, for example. More specifically, the present invention relates to an image recording apparatus which records an image signal of a photographed object onto a recording medium such as a hard disk in a compressed state.

### 10 Description of the prior art

With respect to a generally-used method of recording image signals into a recording medium, there is an FAT (File Allocation Table) system. In this system, a data area and a management area are formed within a recording medium, and the data area is finely divided into unit recording zones each of which is called a cluster. The image signal is recorded into the data area in clusters, and link information (management information) indicating how the clusters to which the image signal are recorded is linked is recorded into the management area. Therefore, even if the image signal is recorded into vacant clusters sporadically distributed due to a repetition of recordings and erasures, it is possible to appropriately reproduce the image signal based on the link information in the management area.

However, in a conventional FAT system, a cluster size is smaller than a frame size the image signal, and the image signal of each frame is recorded into a plurality of clusters. Therefore, if the link information of the cluster is destructed, it is not possible to reproduce the image signal.

## SUMMARY OF THE INVENTION

Therefore, it is a primary object of the present invention to provide a novel image recording apparatus.

It is another object of the present invention to provide an image recording apparatus capable of easily reproducing an image signal even when management information is destructed.

According to the present invention, an image recording apparatus which records image signals in a compressed state into a recording medium on which a plurality of unit recording zones each of which has a first size are formed, comprises: an inputter for inputting image signals; a compressor for compressing each of the image signals inputted by the inputter into a second size which is equal to or smaller than  $1/N$  ( $N$  : integer ) of the first size; and a recorder for respectively recording compressed image signals generated by the compressor into the unit recording zone.

The image signals inputted by the inputter are compressed by the compressor, and the compressed image signals thereby obtained are recorded in the unit recording zones formed in the recording medium. Each unit recording medium has the first size, and the compressed image signals have a second size which is equal to or smaller than  $1/N$  of the first size. This is the reason why  $N$  of the compressed image signals is recorded in each of the unit recording zones. Therefore, even if management information regarding the image signal is destructed, it is still possible to easily reproduce the image signals.

It is preferred that the recorder search unit recording zones each of which is in a vacant state, write the compressed image signals into the discovered unit recording zones, and create link information indicating a link state of the unit recording zones in which the compressed image signals are written.

It is further preferred that a successive identifying number be assigned to each of

the compressed image signals by the assigner. A restorer restores the link information on the basis of the identifying number when accepting a restoring instruction of the link information.

When  $N = 1$  is true, the recorder may bring a forefront of each of the compressed image signals into being coincident with a forefront of each of the unit recording zones.

When  $N \geq 2$  is true, it may be possible that the recorder detects a difference of each size of the compressed image signals and the second size, and an interval equivalent to the difference is formed between a compressed image signal to be recorded this time and a compressed image signal to be recorded next time in the same unit recording zone.

It is preferred that the compressor repeatedly carry out a compression process up to each size of the compressed image signals being equal to or smaller than  $1/N$  of the first size.

It is preferred that each of the image signals be a still image signal, and the compressor perform a compression process in accordance with a JPEG format.

The above described objects and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram showing a constitution of one embodiment of the present invention;

Figure 2 is an illustrative view showing one example of a format of an image file;

Figure 3 is an illustrative view showing one example of structure of a hard disk;

Figure 4 is an illustrative view showing one example of a recording state of a data area formed on the hard disk;

Figure 5 is an illustrative view showing one example of a recording state of a management area formed on the hard disk;

Figure 6 (a) is an illustrative view showing one part of operation of Figure 1 embodiment;

5 Figure 6 (b) is an illustrative view showing another part of operation of Figure 1 embodiment;

Figure 6 (c) is an illustrative view showing still another part of operation of Figure 1 embodiment;

10 Figure 7 is an illustrative view showing one example of a recording state of each cluster forming the data area;

Figure 8 is a flowchart showing one part of operation of Figure 1 embodiment;

Figure 9 is a flowchart showing another part of operation of Figure 1 embodiment;

Figure 10 is a flowchart showing another part of operation of Figure 1 embodiment;

15 Figure 11 is an illustrative view showing one part of operation of another embodiment of the present invention;

Figure 12 is a flowchart showing one part of operation of Figure 11 embodiment; and

20 Figure 13 is a flowchart showing another part of operation of Figure 11 embodiment.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Referring to Figure 1, a surveillance camera apparatus 10 of this embodiment photographs an object which is not shown at a ratio of once in a predetermined period, and records a still image of each object photographed. A CCD light-receiving element 14

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converts an optical image of the object obtained through a lens 12 into an image signal (electric charge) by a photoelectric conversion, and inputs a converted image signal into a signal processing circuit 16. The signal processing circuit 16 subjects a signal processing such as an amplification, a filtering, etc. to the inputted image signal, and applies a processed image signal to a display 18. Thus, a real time moving image of the object is represented on the display 18.

The signal processing circuit 16 also converts the aforementioned image signal into a digital signal, that is, image data in response to a timing signal provided from a timing circuit 20. The image data is inputted into an image compression/expansion circuit 24 via an image memory 22, and subjected to an image compression in accordance with a JPEG format. Thus, an image file shown in Figure 2 is created.

As shown in Figure 2, the image file starts by "SOI" or a start marker. Following "SOI", "APPn" or a marker of an application marker segment, "DQT" or a marker of a quantization table, "DHT" or a marker of a Huffman encoding table, "DRI" or a marker of a restart interval, "SOF" or a marker of a frame header, and "SOS" or a marker of a scan header are added in this order. The compressed image data is present following the scan header "SOS", and "EOI" or an end marker is added to the end of the compression image data. A date on which the image file is created, that is, year-month-day information indicating a photographing date is recorded in the application marker segment.

Note that since the application marker segment is defined by an Exif (Exchange Image File format) system or a DCF (Design rule for Camera File System) system, and a table and a header other than the application marker segment are defined by a JPEG system, a detailed description is herein omitted.

The image file created by the image compression/expansion circuit 24 is

accumulated on a temporary storing memory 26, and thereafter recorded in a hard disk 28a by a hard disk drive 28. Note that the hard disk 28a is held by a spindle motor 28b.

A series of such the operations from the photographing of the object to the recording of the image file is started by an operation of an operation key 32 connected to a CPU 30. More specifically, if a recording starting key (not shown) constituting the operation key 32 is depressed, the CPU 30 writes the image data generated by the signal processing circuit 16 onto the image memory 22 in response to the timing signal produced by the timing circuit 20, and compresses the image data stored in the image memory 22 by controlling the image compression/expansion circuit 24. Then, the image file accumulated in the temporary storing memory 26 is transferred to the hard disk drive 28. The image file is recorded in the hard disk 28a by the hard disk drive 28.

Note that a clock circuit 34 to count a present time is connected to the CPU 30, and the CPU 30 applies to the image compression/expansion circuit 24 the year-month-day information, that is, photographing date information obtained from the clock circuit 34. The photographing date information is written into the application marker segment of the image file by the image compression/expansion circuit 24.

If a stop key (not shown) constituting the operation key 32 is depressed, the CPU 30 stops the series of photographing/recording operations.

Incidentally, the image file recorded in the hard disk 28a is managed by the FAT system. An adoption of the FAT system makes it possible to gain access to the image file in the hard disk 28a from a personal computer (not shown) connected to the CPU 30 via an external interface circuit 36. Note that the personal computer has a similar key to the operation key 32, and the surveillance camera apparatus 10 is remotely controllable by the personal computer.

Referring to Figure 3, the hard disk 28a has a management area 280 formed at an

outer periphery and a data area 282 formed inside the management area 280. The data area 282 is finely divided into a plurality of clusters 284.

In a conventional FAT system, a cluster size  $C$  is set to a relatively small value such as 2kB to 4kB in order to increase utility efficiency of the disk. In contrast, in this embodiment, the cluster size is set to a relatively large value such as several tens of kB to hundreds of kB (64kB to 256kB or so, for example). If a maximum size of the image file is defined as  $F_{\max}$ , the cluster size of this embodiment is  $N$  times ( $N = 1$ , for example) of the maximum size  $F_{\max}$ . Referring to Figure 4, the image file is recorded in the cluster 284 one by one in corresponding order to the photographing date. The link information indicating a using state or a link state of the cluster 284 is recorded in the management area 280 as shown in Figure 5. Each of "f0000001.jpg", "f0000002.jpg" .... represents a file name of each image file.

Note that in a case that an image file is recorded in all of the clusters 284 as shown in Figure 6 (a) (99999 units of clusters in the Figure), a cluster 284 having the oldest photographing date (a cluster in which the image file of "f0000001.jpg" is recorded) is treated as a vacant cluster. As shown in Figure 6 (b), a newly created image file, e.g. "f0100000.jpg" is overwritten into the vacant cluster 284. In addition, as shown in Figure 6 (c), an image file, e.g. "f0100001.jpg" created succeeding to the image file, e.g. "f0100000.jpg" is written into a cluster in which an image file "f0000002.jpg" is recorded.

Referring to Figure 7, the image file is recorded in such a manner that "SOI" is present at a forefront portion of the cluster 284 (left side in Figure 7). Since a size  $F$  of the image file is equal to or smaller than the cluster size  $C$  ( $= F_{\max}$ ), if  $F < F_{\max}$  is true, a redundant portion  $D$  equal to a difference of the file size  $F$  and the cluster size  $C$  ( $= C - F$ ) is formed following the marker "EOI" which is added to a rearmost end of the image file.

Therefore, in this embodiment, arbitrary dummy data (uncertain data) is added to the redundant portion D so as to fill in one cluster 284 with the image file and the dummy data.

The CPU 30 executes a photographing/recording process shown in Figure 8 on a predetermined time interval basis. Note that a control program corresponding to a flowchart shown in Figure 8 is previously stored in a ROM 40.

Referring to Figure 8, the CPU 30 fetches the image data generated in the signal processing circuit 16 onto the image memory 22 in a step S1, and a compression ratio Q (Q factor) of the image compression/expansion circuit 24 is set to an initial value  $Q_0$  in a step S3. Furthermore, a compression process of the image data is instructed to the image compression/expansion circuit 24 in a step S5. At this time, the CPU 30 applies the year-month-day information obtained from the clock circuit 34 to the image compression/expansion circuit 24. The year-month-day information is written into the application marker segment by the image compression/expansion circuit 24.

The CPU 30 writes the image file generated by the image compression/expansion circuit 24 onto the temporary storing memory 26 in a step S7. The CPU 30 further obtains the size F of the image file from the image compression/expansion circuit 24 in a step S9, and compares the size F in question to a maximum size  $F_{max}$  ( $= C$ ) in a step S11. If the obtained size F is equal to or smaller than the maximum size  $F_{max}$ , the CPU 30 proceeds to a step S13. On the other hand, if the size F is bigger than the maximum size  $F_{max}$ , the CPU 30 increases the compression ratio Q by one degree ( $= \Delta Q$ ) in a step S15, and subsequently returns to the step S5. The image data is compressed once again in accordance with the renewed compression ratio Q.

Proceeding to the step S13, the CPU 30 compares the size F to a previously determined minimum size  $F_{min}$ . If the size F is equal to or bigger than the minimum size



Fmin, the CPU 30 determines that the size F is an appropriate size, and proceeds to a step S17. On the other hand, if the size F is smaller than the minimum size Fmin, the CPU 30 determines that the size F is excessively small, and returns to the step S5 after decreasing the compression ratio Q by one degree ( $= \Delta Q$ ) in a step S19. The image data is once again compressed in accordance with the renewed compression ratio Q.

The CPU 30 determines a difference D of the size F and the cluster size C in the step S17, and adds dummy data in a size equal to the difference D to an rear end of the image file in a step S21. Subsequently, the CPU 30 adds a file name (a file number) to the image file in a step S23, and searches a vacant cluster 284 from the hard disk 28a in a step S25. The CPU 30 further records the image file in the vacant cluster 284 in a step S27, and renews the link information (FAT) of the management area corresponding to the cluster 284 in which the image file is recorded in a step S29.

The image file thus recorded in the hard disk 28a is to be reproduced in an image reproducing mode. When a reproduction instruction of a desired image file is applied in the image reproduction mode, more specifically, when the desired image file is selected by an image designating key (not shown) constituting the operation key 32, and a reproduction start key (not shown) is operated, the CPU 30 instructs the hard disk drive 28 to reproduce the selected image file. The hard disk drive 28 reproduces the desired image file from the hard disk 28a, and stores the reproduced image file onto the temporary storing memory 26. Note that in the image reproduction mode, it may be possible to successively reproduce a plurality of image files in response to one reproducing instruction.

The image file stored on the temporary storing memory 26 is expanded in the JPEG format by the image compression/expansion circuit 24. The expanded image data is inputted into the signal processing circuit 16 via the image memory 22. The signal

processing circuit 16 converts the inputted image data into an analog signal, that is, an image signal, and the converted image signal is applied to the display 18. Therefore, a reproduced image of an object is represented on the display 18. Note that if the stop key constituting the operation key 32 is depressed, the CPU 30 suspends the series of reproducing operations, and finishes the image reproduction mode.

Note that a timing to write the image file onto the temporary storing memory 26 from the hard disk 28a, a timing to expand the image file stored on the temporary storing memory 26 by the image compression/expansion circuit 24, a timing to store the expanded image data onto the image memory 22, and a timing to convert the image data into the image signal by the signal processing circuit 16 are controlled on the basis of the timing signal produced by the timing circuit 20. Furthermore, if the image file read from the hard disk 28a is transferred to the personal computer via the external interface circuit 36, it is also possible to reproduce the image file in question by the personal computer.

The CPU 30 executes an image reproduction process according to a flowchart shown in Figure 9. Note that a controlling program corresponding to the flowchart is also previously stored in the ROM 40.

Referring to Figure 9, the CPU 30 considers a cluster 284 including an image file designated by the operation key 32 as a subject to be read in a step S31, and instructs the hard disk drive 28 to read the image file from the cluster 284 in a step S33. The image file read by the hard disk drive 28 is stored on the temporary storing memory 26. The CPU 30 detects the compression ratio Q of the image file stored on the temporary storing memory 26 in a step S35, and instructs the image compression/expansion circuit 24 to carry out an expansion process according to the detected compression ratio Q in a step S37.

The CPU 30 determines whether or not the reproducing instruction from the operation key 32 is a successive reproduction in a step S39 after a completion of the

expansion process by the image compression/expansion circuit 24 . If the successive reproduction is herein determined, the CPU 30 considers a cluster in which an image file to be reproduced next is recorded as a subject to be read in a step S41, and subsequently returns to the step S33. On the other hand, if NO is determined in the step S39, the CPU 30 finishes a reproduction operation.

Incidentally, if the link information recorded in the management area 280 of the hard disk 28a is destructed, it is not possible to reproduce the image file in a reproducing process shown in Figure 9. This is the reason why the surveillance camera apparatus 10 of this embodiment is also provided with a function to restore to a normal state capable of reproducing the image file by the reproducing process shown in Figure 9. This restoring operation of the image file is done in a restoring mode.

Note that prior to the restoring mode, a recovery-use hard disk drive 38 is connected to the CPU 30 in addition to a defective hard drive 28 having the destructed link information. Similar to the above hard disk drive 28, the recovery-use hard disk drive 38 also contains a hard disk 38a and a spindle motor 38b for holding the hard disk 38a. Furthermore, the recovery-use hard disk drive 38a has a storing capacity at least bigger than that of the defective hard disk 28a, and is formed of a similar management area and a data area to the hard disk 28a.

When a restoring starting key (not shown) constituting the operation key 32 is depressed in order to restore the image file recorded on the hard disk 28a, the CPU 30 enters in the restoring mode. Firstly, the CPU 30 reads cluster data including the image file from each cluster 284 formed on the defective hard disk 28a, and records the read cluster data into the hard disk 38a in the recovery-use hard disk drive 38. At the same time, the link information for managing the cluster of the recovery-use hard disk drive 38a is written into the management area of the recovery-use hard disk drive 38a. Note

that a photographing date of the restored image file is to remain as a previous date.

In the restoring mode, the CPU 30 carries out a flowchart shown in Figure 10. Note that a program corresponding to the flowchart is also previously stored in the ROM 40.

5 Referring to Figure 10, the CPU 30 considers a first cluster 284 (a cluster 284 including an image file to which the smallest number is assigned as a file name, for example) out of each cluster 284 in the defective hard disk 28a as a subject to be read in a step S51. Subsequently, in a step S53, the CPU 30 instructs the hard disk drive 28 to read cluster data recorded in the cluster 284 which is a subject to be read. The cluster data read by the hard disk drive 28 is written onto the temporary storing memory 26.

10 The CPU 30 determines whether or not forefront data of the cluster data stored on the temporary storing memory 26 is "SOI" in a step S55. If YES is herein determined, the CPU 30 understands that at least a forefront portion of the read cluster data is not destroyed, and there is a possibility to appropriately restore the image file. Then, the process proceeds to a step S57.

15 On the other hand, if NO is determined in the step S55, the CPU 30 determines that it is not possible to appropriately restore the image file, and considers a next cluster 284 as a subject to be read in a step S59. More specifically, the CPU 30 considers a cluster 284 including an image file to which the second smallest number next to the cluster 284, e.g. a subject to be read at present is attached as a subject to be read. Upon completion of the step S59, the CPU 30 returns to the step S53.

20 Upon proceeding to the step S57, the CPU 30 determines whether or not "EOI" is present in the cluster data stored on the temporary storing memory 26. If YES is herein determined, the CPU 30 considers that it is possible to appropriately restore the image file included in the cluster data in question, and then proceeds to a step S61. On the other

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hand, if NO is determined in the step S57, the CPU 30 considers that it is not possible to appropriately restore the image file, and then returns to the step S53 via the step S59.

The CPU 30 obtains the photographing date information from the application marker segment of the image file included in the cluster data stored on the temporary storing memory 26 in the step S61, and directly records the cluster data into the data area of the recovery-use hard disk 38a in a step S63. Subsequently, the CPU 30 creates link information of the cluster in which the cluster data is recorded in a step S65, and records the created link information in the management area of the recovery-use hard disk 38. Furthermore, the CPU 30 writes the photographing date obtained in the above step S61 toward the application marker segment of the image file recorded in the recovery-use hard disk 38a in a step S67.

Subsequently, the CPU 30 determines whether or not the cluster data is read from all of the clusters 284 in the defective hard disk 28a in a step S69. If NO is determined, the process returns to the step S53 via the step S59. On the other hand, if YES is determined in the step S69, the CPU 30 finishes the restoring process.

In another embodiment of the present invention, it is possible to record ( $N \geq 2$ ) of image files into one cluster 284.

In this case, each cluster size C is N times of the maximum size Fmax of the image file as shown in Figure 11 ( $N = 2$  in Figure 11). Each cluster 284 is divided into N of portion areas, and one image file is recorded in one portion area. At this time, the image file is recorded in such a manner that "SOI" is present at a forefront of the portion area. Furthermore, a redundant portion D is formed between "EOI" of the image file and "SOI" of a next image file. Similar to the above embodiment, dummy data is recorded in the redundant portion D.

When the N of image files are thus recorded in one cluster 284, the CPU 30 carries

out a flowchart shown in Figure 12 between the step S23 and the step S25 shown in Figure 8.

In other words, after adding a file number to the image file in the step S23 in Figure 8, the CPU 30 accumulates the image file to which the file number is added in the temporary storing memory 26 in a step S71 shown in Figure 12. Subsequently, the CPU 30 determines whether or not the number of image files accumulated in the temporary storing memory 26 reaches to N in a step S73, and the process returns to the step S1 if the number is less than N. On the other hand, if the N of image files are accumulated in the temporary storing memory 26, the CPU 30 proceeds from the step S73 to the step S25 shown in Figure 8.

In addition, when an arbitrary image file is reproduced from the hard disk 28a on which N of image files ( $N \geq 2$ ) are recorded in one cluster, the CPU 30 carries out a flowchart shown in Figure 13 between the step S39 and the step S41 shown in Figure 9.

That is, when the successive reproduction is determined in the step S39 in Figure 9, the CPU 30 determines whether or not an image file following the image file to be reproduced at present is present in the identical cluster 284 in a step S81 shown in Figure 13. If YES is herein determined, the CPU 30 returns to the step S35 in Figure 9 in order to reproduce the image file. On the other hand, if NO is determined in the step S81, the CPU 30 proceeds to the step S41 in Figure 9 in order to consider a next cluster 284 as a subject to be read.

As understood from the above descriptions, the cluster size C is set as being equal to or bigger than the file size F of the image file, and the image file is recorded in such a manner that "SOI" is present at a forefront of the cluster 284. This is the reason why it does not occur that one image file is recorded in a plurality of clusters 284. Therefore, even if the link information in the management area 280 is destructed, it is possible to



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